Claims

1. A method of manufacturing a microstructured fibre, comprising:

(i) providing a preform comprising a plurality of elongate holes;

(ii) mating at least one of the holes with a connector to connect the hole(s) to an external pressure-controller;

(iii) drawing the preform into the fibre whilst controlling gas pressure in the hole(s) connected to the pressure-controller.

2. A method as claimed in claim 1, in which the preform comprises a plurality of elongate elements, arranged side by side in a bundle, a plurality of the elements being tubes, wherein each tube defines one of the holes in the preform.

3. A method as claimed in claim 1, in which the preform comprises a matrix material that defines the holes.

4. A method as claimed in any preceding claim, in which the external pressure-controller increases the pressure in the hole above atmospheric pressure.

5. A method as claimed in any of claims 1 to 3, in which the external pressure-controller decreases the pressure in the hole below atmospheric pressure.

6. A method as claimed in any preceding claim, in which the pressure in the hole is kept constant throughout the drawing of the fibre.

7. A method as claimed in any of claims 1 to 5, in which the pressure in the hole is varied during the draw.

8. A method as claimed in claim 6, in which the pressure is pulsed periodically.

9. A method as claimed in any preceding claim, in which a plurality of the holes are connected to the external pressure-controller.

10. A method as claimed in any preceding claim, the method including the step of pressurising further groups, each

comprising at least one of the holes, to a second pressure or pressures.

11. A method as claimed in any preceding claim, the method including the step of varying over time the rate at which the fibre is drawn from the preform.

12. A method as claimed in any preceding claim, the method including the step of varying over time the preform feed rate.

13. A method as claimed in any preceding claim, the method including the step of varying over time the furnace temperature.

14. A method as claimed in any preceding claim, in which the pressurisation results in at least one elongate hole formed in the drawn fibre having a different transverse area in one part of the fibre from its transverse area in another part of the fibre.

15. A method as claimed in any preceding claim, in which the pressurisation results in at least one part of the dielectric matrix region having a different transverse area in one part of the fibre from its transverse area in another part of the fibre.

16. A method as claimed in claim 15, in which at least one hole is completely collapsed over a length of the fibre.

17. A method as claimed in any preceding claim, in which the pressurisation results, in a transverse cross-section of the drawn fibre, in a plurality of concentric regions, wherein alternate adjacent regions are of a higher and a lower effective refractive index respectively.

18. A method as claimed in any preceding claim, in which the pressurisation results in the drawn fibre being a W-profile fibre over at least part of its length.

19. A method as claimed in any preceding claim, the method including the step of producing a plurality of devices arranged axially along the PCF by varying over time the pressure applied to the hole or holes.

20. A method as claimed in any preceding claim, in which the pressurisation results in the drawn fibre comprising a long period grating.

21. A method as claimed in any preceding claim, in which the variation in pressurisation results in a change in the symmetry of the fibre, such that a portion of the fibre is birefringent.

22. A method as claimed in claim 21, in which two portions of the fibre are birefringent and their principal polarisation axes are rotated relative to each other by the variation in pressurisation.

23. A method as claimed in claim 22, in which the distribution of pressure in the holes is altered part-way through the draw so as to make the slow axis into a fast axis and vice-versa.

24. A method as claimed in any of claims 21 to 23, in which further portions of the fibre may be birefringent and have rotated polarisations.

25. A method as claimed in any preceding claim, in which the variation in pressurisation results in a change in core size in the drawn fibre, such that the fibre comprises a fibre portion having a larger core region and a fibre portion having a smaller core region.

26. A method as claimed in any preceding claim, in which the variation in pressurisation results in a change in core size, such that the fibre comprises a nonlinear fibre portion, comprising a core region that is sufficiently small for significant nonlinear optical effects to occur in use.

27. A method as claimed in any preceding claim, in which the drawn fibre comprises a plurality of core regions.

28. A method as claimed in claim 27, in which the variation results in the separation of at least two of the cores being reduced in a region of the fibre, such that the fibre comprises an optical coupler comprising the reduced separation region.

29. A method as claimed in claim 28, in which the fibre comprises two such optical couplers that form a Mach-Zehnder interferometer.

30. A method as claimed in claim 28 or claim 29, in which the fibre comprises a network of switches and/or filters formed from a plurality of such couplers.

31. A method as claimed in claim 27, in which the fibre comprises more than two cores.

32. A method as claimed in claim 31, in which the variation results in the separations of the cores being reduced over a plurality of portions of the fibre to form optical couplers between each of the more than two cores.

33. A method as claimed in any preceding claim, in which a transition region formed between each of a plurality of optical devices formed in the fibre is sufficiently gradual to be adiabatic.

34. A method as claimed in any preceding claim, in which the condition of the draw is oscillated between two states over time to form a transition region, the first state being matched to the mode of a first optical device comprised within the fibre and the second state being matched to the mode of a second of optical device comprised within the fibre.

35. A method as claimed in any preceding claim, the method includes the step of manufacturing twist-compensated DGD-free fibre by oscillating the structure to and fro periodically along the length of the drawn fibre.

36. A method as claimed in any preceding claim, in which the pressure is oscillated during the draw to avoid unwanted nonlinear effects by oscillating the fibre structure around a desired structure that satisfies an unwanted phase-matching condition.

37. A method as claimed in any preceding claim, in which the method includes the step of producing a DCF with graded properties that match the dispersion curve in standard telecomms fibre over the telecommunications bands.

38. A method as claimed in any preceding claim, in which the method includes the step of calibrating the relationship between parameters of the draw and parameters of the drawn fibre.

39. A method as claimed in claim 38, in which the method further comprises varying parameters of the draw according to the calibration results to produce a fibre having a selected structure.

40. A method as claimed in any preceding claim, in which the pressure applied to the or each hole is controlled by a digital signal.

41. A method as claimed in any preceding claim, in which a portion of the preform is retained undrawn during the drawing of the fibre, and individual connections are made directly, for example via a hose, from one or more external pressure-controllers to each hole or holes to be pressurised by that pressure-controller.

42. A method as claimed in any of claims 1 to 40, in which a connector is provided to connect the holes to the external pressure-controller.

43. A connector for connecting a preform, which is for a microstructured fibre and which comprises a plurality of holes, to a pressure source, the connector comprising a plurality of elements arranged to mate with one or more of the holes, each element being connectable to a pressure source.

44. A connector as claimed in claim 43, in which different ones of the elements are connectable, individually or in groups, to different pressure sources.

45. A connector as claimed in claim 43 or claim 44, in which the preform comprises a plurality of tubes and the elements are chambers in which one or more of the tubes terminate.

46. A connector as claimed in claim 45, in which each chamber is in fluid communication with a passage that is connectable to the pressure source.

47. A connector as claimed in claim 45 or claim 46, in which the chambers are distributed in the connector in a plane

substantially orthogonal to the direction in which the tubes are intended to pass through the apertures.

48. A connector as claimed in claim 47, in which the chambers are adjacent to the apertures.

49. A connector as claimed in claim 48, in which the chambers are recesses in a side of the connector.

50. A connector as claimed in any of claims 43 to 48, in which the chambers are distributed in the connector along the direction in which the tubes are intended to pass through the aperture.

51. A method as claimed in any of claims 1 to 42, further comprising the step of mating a connector as claimed in any of claims 41 to 50 with an end of the preform such that the elements of the connector mate with at least some of the holes, connecting the elements to one or more external pressure-controllers and pressuring the holes to one or more selected pressure during the draw.

52. A method of manufacturing a microstructured optical waveguide, comprising:

(i) providing a preform in which there are a plurality of holes running side-by-side through the preform;

(ii) coupling a pressure-controller to one or more, but not all, of the holes for controlling the gas pressure in those holes;

(iii) drawing the preform into an optical waveguide while controlling the gas pressure in the holes that are coupled to the pressure-controller.

53. A fibre made by a method according to any of claims 1 to 43, 51 or 52.